

Remarks

This paper is filed in response to the office action within the shortened statutory period set forth in the office action dated October 30, 2003.

Please enter the following amendments and remarks into the prosecution history of the subject application without prejudice or disclaimer.

I. In the claimsA. Amendments

Please replace currently pending claim 1 with amended claim 1. New claims 23-25 have been added. Currently pending claims 8-22 have been canceled without prejudice or disclaimer with this response. The claims that are pending prior to the entry of the amendments in this response are called "currently pending claims". Upon amendment, the above-identified US patent application will have 1 independent claim (amended claim 1) and 10 total claims (currently amended claims 1-7 and new claims 23-25).

Applicants have previously paid for up to 22 claims and 3 independent claims.

Therefore, no fee for excess claims is required with this response.

B. Support for amended claims

The support for amended claim 1 can be found in, inter alia, currently pending claims 1 and 8, on page 3, lines 18-20 and page on page 5, lines 18-19. The support for new claims 23-25 can be found in, inter alia, on page 5, lines 1-20.

II. Claim rejections under 35 U.S.C. 103A. Rejection of currently pending claims 1-7, 9-22

The Examiner's rejection of currently pending claims 1-7 and 9-22 under 35 U.S.C. 103(a) raised on pages 2-5 of the office action as being unpatentable over Kang (U.S. Patent Application No. 2002/0045353 A1) in view of Kim (U.S. Patent No. 6,316,349) and further in view of Thei (U.S. Patent No. 6,335,249) are moot in view of amended claim 1 and, as amended, now corresponds to old claim 8.

B. Rejection of formerly pending claim 8 (Now Claim 1)

The Examiner rejected on pages 5-6 of the office action, formerly pending claim 8 under 35 U.S.C. 103(a) as being unpatentable over Kang in view of Thei and further in view of Prall (U.S. Patent No. 6,337,244).

The Examiner asserts that Kang teaches a method of forming a self-aligned contact hole by etching the silicon oxide layer using $C_5F_8/CHF_3/Ar$, but fail to teach the specific C_5F_8/CHF_3 mixture ratio of the etching gas that is between 0.4-0.75. The Examiner asserts that using C_5F_8/CHF_3 mixture ratio of etching gas that is between 0.4-0.75 to etch oxide layer is allegedly evidenced by Prall. The Examiner asserts that Prall teaches forming a self-aligned contact hole using mixture of C_5F_8/CHF_3 gas at ratio of between about 0.2-5 (see Prall's claims 6, 39 and column 6, lines 27-35 and column 8, lines 1-14).

The Examiner asserts that it would have been obvious to a person of ordinary skill in the art to use a mixture of C_5F_8/CHF_3 gas with a ratio of 0.4-0.75 to etch a self-aligned contact hole in the process of Kang because the higher the etching selectivity of silicon oxide to silicon nitride layer would prevent over etching on the gate electrode. The Examiner's assertion is respectfully traversed in regard to the formerly pending claim 8 and currently amended claim 1 for the following reasons.

1. Amended claim 1

Amended claim 1 now has the following wording:

“A method of forming a self-aligned contact hole suitable for a semiconductor substrate having a pair of gate electrodes, comprising the steps of:
forming a nitride etching stop layer over the gate electrode and the semiconductor substrate;
forming an oxide insulating layer on the nitride etching stop layer; and
plasma-etching the oxide insulating layer by an etching gas consisting of C₅F₈ and CHF₃ so as to form a self-aligned contact hole between the pair of gate electrodes, wherein the C₅F₈/CHF₃ mixture ratio of the etching gas is between 0.4 and 0.75, thereby equalizing the etching rate to the etching stop layer at the top corner and the bottom of the contact hole.”

2. Re: Prall

Prall teaches in claims 6 and 39 that all non-hydrogen containing fluorocarbons are present in the gas chemistry at a volumetric ratio of from about 5:1 to about 0.2:1 as compared to all hydrogen containing fluorocarbon gases.

Applicants submit that the range from about 5:1 to about 0.2:1 is a very wide range. It is more than 10 times larger than the range of 0.4 to 0.75.

The following table makes the difference between the claimed mixture ratio and as taught by Prall apparent:

	C_5F_8/CHF_3	C_5F_8/CHF_3
Amended Claim 1	0.75	0.4
Claim 6 of Prall	5:1	1:5

It becomes clear that the claimed mixture contains from 1.33 to 2.5 times the volume of CHF₃ to C₅F₈. Prall, however, teaches that the mixture can contain about 5 times the volume of C₅F₈ to CHF₃.

Prall teaches a much wider range and does not teach or suggest to choose a mixture with only a higher amount of CHF₃. To the contrary, Prall teaches in claims 7 and 40 a volumetric ratio from about 1.2:1 to about 0.8:1 as compared to all hydrogen-containing fluorocarbons. Therefore, Prall teaches and suggests a different range than the claimed invention.

Kang and Prall do not teach or suggest all the claim limitations of amended claim 1. The Applicants submit that the results obtained by the claimed mixture ratio are unexpected and surprising in view of Kang and further in view of Prall. Further, the claimed mixture is critical. The Applicants further submit that the etching stop layer at the top corner and the bottom of the contact hole are equalized when a mixture of C₅F₈/CHF₃ etching gas with a ratio of 0.4 to 0.75 is utilized. See page 3, lines 16-26. Neither the top corner nor the bottom of the contact hole is over etched. Accordingly, it provides unexpected advantages in view of the combination of the prior art as taught by Kang and Prall.

The person skilled in the art would not be motivated by the teaching of Prall to modify the suggested mixture ratio by Prall and to make the claimed invention. Prall does not

suggest that one modify the ratio according to the claimed invention.

There would certainly be no expectation of success to combine the teachings of Kang and Prall because the person skilled in the art would only be motivated to apply the mixture ratio in a very wide range of about 5:1 to about 1:5. The person skilled in the art would be at most motivated to choose a ratio from about 1.2:1 to about 0.8:1. See Prall, claims 7 and 40. This ratio, however, is outside of the ratio of the claimed invention.

C. Rejection of claim 8 under 35 U.S.C. 103(a) based on case law

The Examiner further asserts on page 6 of the office action that it has been held that when the general condition of a claim are disclosed in the prior art that it is not inventive to discover the optimum or workable ranges (see In re Aller 105 USPQ 233 (CCPA 1955)) and further that optimization of known result effective variables is obvious (see In re Antonie 559 F.2d 618, 195 USPQ 6 (CCPA 1977)).

Applicants reviewed and briefed the two CCPA cases In re Aller and In re Antonie and submit the following observation.

1. In re Aller

Appellant's application for patent involved a process for the production of carbolic acid as an ingredient in the production of drugs and explosives. However, the process was identical with that of the prior art except that appellant's claims specify lower temperatures and higher sulfuric acid concentrations than were previously shown...The court asserted that experimentation to find the optimum conditions of temperatures and acid concentration was no more than the application of the expected skill of a chemical engineer. The court held that there was no record to support a holding of a patentable invention.

2. The claimed process in view of Kang

Kang teaches etching of a silicon oxide containing layer 56 which covers the silicon nitride layer 54. Layer 56 is etched, resulting in the contact hole 57. The area of the contact hole 57 on the substrate was not covered with silicon nitride layer 54 prior to the step of etching. See Figures 2a and 2b and paragraphs 33-35. Further, Kang teaches the etch gas which contains C_4F_8 which can further include another C_xF_y -based gas, therefore a gas mixture of C_4F_8 . Therefore the process as described by Kang is not identical to the claimed process

3. The claimed process in view of Prall

Similar to Kang, Prall does not teach covering the area of the self-aligned contact hole on the substrate 18 with a SiN etch stop layer 30. Prall does not even teach covering this area on the substrate 18 with the masking layer 36. See Figures 6-11.

For the foregoing reasons and as explained in regard to the different gas mixture ratio in the previous sections, the process of Prall is not identical to the claimed process.

Kang and Prall do not teach or suggest equalizing the etching rate to the etching stop layer at the top corner and the bottom of the contact hole. Applicants submit that the decision on In re Aller is not relevant to the claimed invention.

4. In re Antonie

In Re Antonie the court noted that the invention as a whole was the ratio value of 0.12 and its inherent and disclosed property, and that it was the whole invention which must be obvious under §103. Reviewing the prior art, the court found that it did not reveal the property which appellant discovered and, therefore, there was no basis to find obviousness. Furthermore, while recognizing that the general rule stated that the

discovery of an optimum value of a variable in a known process was normally obvious, the court noted exceptions were found where the parameter optimized was a result-effective variable. The court found this to be such a case. Thus, the board's decision was reversed.

The court reversed the decision of the board because the claims were not obvious since the prior art did not reveal the property which appellant discovered and discovery of the optimum ratio value was a result-effective variable.

- a) The court was of the following opinion. "In re Aller, 42 CCPA 824, 22 F.2d 454, 105 USPQ 233 (1955) the court set out the rule that the discovery of an optimum value of a variable in a known process is normally obvious. We have found exceptions to this rule in cases where the results of optimizing a variable, which was known to be result effective, were unexpectedly good."
- b) The court was further of the following opinion. "The controlling question is simply whether the differences between the prior art and the appellant's invention as a whole are such that appellants invention as a whole would have been obvious. The answer is no."

In Re Antonie clearly limits the ambit of In Re Aller.

It is impossible to recognize from the prior art, i.e. Kang and Prall and further Thei, that the C₅F₈/CHF₃ mixture ratio of the etching gas should be between 0.4 and 0.75, thereby equalizing the etching rate to the etching stop layer at the top corner and the bottom of the contact hole.

For the foregoing reasons, the Examiner should withdraw his assertion that it would have been obvious to someone with ordinary skill in the art to modify the cited references. And because the prior art does not teach or suggest modifying the cited references to produce Applicant's claimed invention, currently amended claim 1 is non-

obvious over the prior art.

The remaining claims (currently amended claims 2-7 and new claims 23-25 are non-obvious over the prior art at the very least because they are each dependent on a non-obvious base claim (currently amended claim 1). In addition, the remaining claim are further non-obvious over the prior art because the prior art does not teach or suggest the particular limitations that are claimed in these subclaims.

Reconsideration of the amended application is respectfully requested. The application is now in condition for allowance. Allowance of the application at an early date is respectfully requested.

Applicants reserve the right to seek protection for any unclaimed subject matter, either subsequently in the prosecution of the present case or in a divisional or continuation application.

This response amends currently pending claims 1-7 and cancels currently pending claim 8-22 and adds new claims 23-25. The amendments and cancellations that are described in the preceding sentence were done to more fully claim the invention and/or to improve the wording of the claims and were not done to overcome rejections under 35 U.S.C. 112, to overcome the prior art or to overcome any other rejections or objections.

The amendments and cancellations that are described in the first sentence of this paragraph shall not be considered necessary to overcome rejections under 35 U.S.C. 112, shall not be considered necessary to overcome the prior art, and shall not be considered necessary to overcome any other rejections or objections.

The Commissioner is authorized to charge any additional fees which may be required or credit overpayment to deposit account no. 12-0415. In particular, if this response is not timely filed, then the Commissioner is authorized to treat this response as including a petition to extend the time period pursuant to 37 CFR 1.136 (a) requesting an extension of time of the number of months necessary to make this response timely filed and the petition fee due in connection therewith may be charged to deposit account no. 12-0415.

I hereby certify that this correspondence is being deposited with the United States Post Office with sufficient postage as first class mail in an envelope addressed to Commissioner for Patents

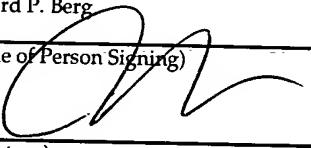
POB 1450, Alexandria, VA 22313-1450 on

January 30, 2004

(Date of Deposit)

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